

Claims

- [c1] A method of adaptively reducing noise within an x-ray image comprising:
receiving raw data from an x-ray detector representing a detected x-ray signal from an object;
generating a counts-based modulation mask in response to said raw data;
generating a structure dependent noise filtered image in response to said raw data; and
generating a noise reduced image in response to said counts-based modulation mask and said structure dependent noise filtered image.
- [c2] A method as in claim 1 further comprising:
generating a structure gradient mask in response to said raw data; and
generating said noise reduced image in response to said structure gradient mask.
- [c3] A method as in claim 1 further comprising:
normalizing said raw data in response to a dose-sensitivity setting of said x-ray detector; and
generating said noise reduced image in response to said normalization.

- [c4] A method of adaptively reducing noise within an x-ray image having a plurality of pixels comprising:
receiving raw data representing a detected x-ray signal from an object;
generating a counts-based modulation mask in response to said raw data;
generating a structure gradient mask in response to said raw data; and
generating a noise reduced image in response to said counts-based modulation mask and said structure gradient mask.
- [c5] A method as in claim 4 further comprising:
executing a structural analysis of said raw data to derive a structure dependent noise filtered image; and
generating said noise reduced image in response to said structure dependent noise filtered image.
- [c6] A method as in claim 4 wherein said structure gradient mask is generated in response to execution of a structural analysis of said raw data.
- [c7] A method as in claim 4 wherein generating said noise reduced image comprises:
generating a conditioned structure mask in response to said raw data; and

blending said counts-based modulation mask and said conditioned structure mask to generate a blended image having a plurality of blended values.

[c8] A method as in claim 7 wherein blending comprises modulating said blending values at each pixel location of said plurality of pixels in response to said counts-based modulation mask and said conditioned structure mask.

[c9] A method as in claim 4 further comprising:
executing a structural analysis of said raw data to derive a structure dependent noise filtered image and to generate a conditioned structure mask;
blending said raw data, said counts-based modulation mask, said structure dependent noise filtered image, and said conditioned structure mask to generate a blended image; and
generating said noise reduced image in response to said blended image.

[c10] A method as in claim 9 wherein said blended image is generated in response to a final mask defined as the multiplication of said counts-based modulation mask and said conditioned structure mask.

[c11] A method as in claim 10 wherein said blended image is generated in response to the multiplication of said struc-

ture dependent noise filtered image, said final mask, and a predetermined blend parameter.

[c12] A method as in claim 10 wherein said blended image is generated in response to the multiplication of said raw data by a subtracted result of one minus a multiplied result of a predetermined blend parameter and said final mask.

[c13] A method as in claim 4 further comprising:
generating a conditioned structure mask in response to said structure gradient mask; and
generating said noise reduced image in response to said conditioned structure mask.

[c14] A method as in claim 13 wherein said conditioned structure mask is generated in response to a low count modulation of said raw data and a weighted function.

[c15] A method as in claim 13 wherein generating said conditioned structure mask comprises:
generating a gradient threshold value;
generating a gradient threshold scaler;
generating a weighted function in response to said structure gradient mask, said gradient threshold value, and said gradient threshold scaler; and
generating said conditioned structure mask in response

to said raw data and said weighted function.

[c16] A method as in claim 13 wherein said conditioned structure mask is generated in response to a low count limit and a low count flat.

[c17] A method as in claim 4 wherein said counts-based modulation mask represents a weighting function on absolute detected intensities comprising effects of imaging system gain.

[c18] A method as in claim 4 wherein generating said noise reduced image comprises:
generating a plurality of blended values in response to said counts-based modulation mask and said structure gradient mask; and
intensity matching said plurality of blended values.

[c19] A method as in claim 18 wherein intensity matching said plurality of blended values comprises equalizing intensity levels of said blended image.

[c20] A method as in claim 4 wherein generating a counts-based modulation mask comprises assigning each pixel location of the plurality of pixels a weight in response to a detected signal level at that location.

[c21] A method as in claim 20 wherein said weight is assigned

in response to a count modulation curve.

- [c22] A method as in claim 21 wherein said count modulation curve is selected from a group of count modulation curves.
- [c23] A method as in claim 22 wherein said group of count modulation curves comprises a low noise reduction curve, a medium noise reduction curve, and a high noise reduction curve.
- [c24] A method as in claim 20 wherein said count modulation curve comprises at least one segment selected from a primary offset segment, a primary roll-off segment, secondary offset segment, a secondary roll-off segment, primary offset segment with constant weighting, a primary roll-off segment with decreasing weighting, secondary offset segment with constant weighting, and a secondary roll-off segment with decreasing weighting.
- [c25] A method as in claim 20 wherein at least a portion of said count modulation curve is in a form of a Gaussian distribution.
- [c26] A method as in claim 4 wherein generating said noise reduced image comprises:
generating blended values in response to said counts-based modulation mask and said structure gradient

mask; and

generating said noise reduced image in response to said blended values, smoothing of said raw data, and smoothing of said blended values.

[c27] A computer processing system for facilitating signal-adaptive noise reduction in x-ray images comprising: an input device receiving raw data representing a detected x-ray signal from an object; and a processor receiving said raw data and generating a counts-based modulation mask; said processor generating a noise reduced image in response to said counts-based modulation mask.

[c28] A system as in claim 27 further comprising: a filter generating a structure dependent noise filtered image in response to said raw data; said processor generates a structure gradient mask in response to said raw data and generates said noise reduced image in response to said raw data, said structure dependent noise filtered image, and said structure gradient mask.

[c29] A system as in claim 28 wherein generating said noise reduced image comprises: deriving a conditioned structure mask in response to said structure gradient mask; and

blending said raw data, said counts-based modulation mask, said structure dependent noise filtered image, and said conditioned structure mask.

- [c30] An x-ray system for adaptively reducing noise within an x-ray image comprising:
an x-ray source generating x-rays;
an x-ray detector receiving said x-rays and generating raw data; and
a controller generating a counts-based modulation mask, a structure gradient mask, and a structure dependent noise filtered image in response to said raw data, and generating a noise reduced image in response to said raw data, said counts-based modulation mask, said structure dependent noise filtered image, and said structure gradient mask.
- [c31] A system as in claim 30 wherein generating said noise reduced image comprises:
deriving a conditioned structure mask in response to said structure gradient mask; and
blending said raw data, said counts-based modulation mask, said structure dependent noise filtered image, and said conditioned structure mask.